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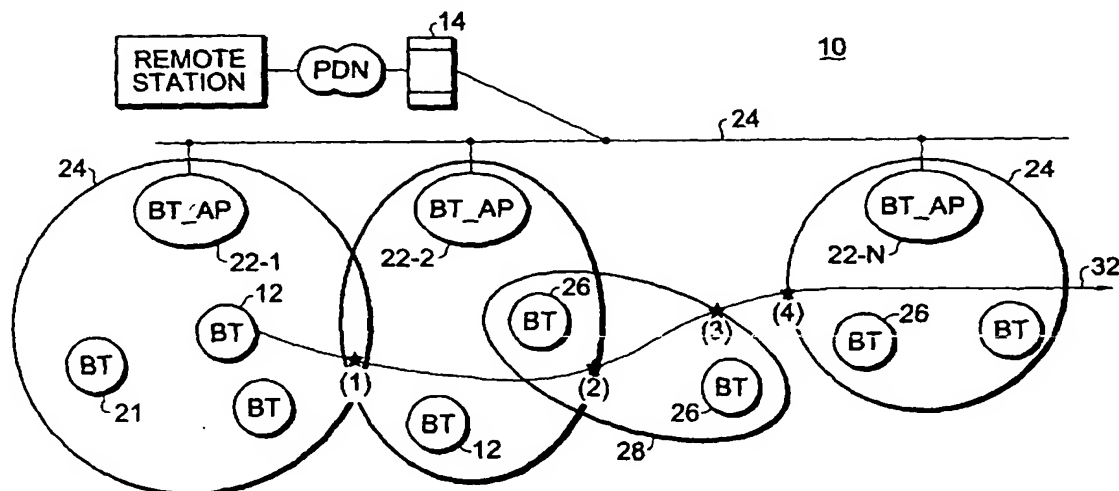
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(54) Title: METHOD, AND ASSOCIATED APPARATUS, FOR EFFECTUATING HANDOVER OF COMMUNICATIONS IN A  
BLUETOOTH, OR OTHER, RADIO COMMUNICATION SYSTEM



(57) Abstract: A method, and associated apparatus, facilitates handover of communications with a mobile Bluetooth device (12) operable to communicate packet data with other Bluetooth devices (12, 26). Handover of communications is effectuated between fixed-infrastructure access points (22) or other mobile Bluetooth devices (12, 26) formed in a scatternet. The device (12, 26) to which communications are to be handed-over becomes a slave to the Bluetooth device (12) with which communications are ongoing, thereby to permit time synchronization thereto.

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METHOD, AND ASSOCIATED APPARATUS, FOR EFFECTUATING  
HANDOVER OF COMMUNICATIONS IN A BLUETOOTH, OR OTHER,  
RADIO COMMUNICATION SYSTEM

The present invention relates generally to a  
5 manner by which to handover communication with a  
mobile Bluetooth-compatible (BT), or other  
communication, device from an active communication  
device to a target communication device. More  
particularly, the present invention relates to a  
10 method, and an associated apparatus, for facilitating  
handover of communications of the mobile Bluetooth, or  
other, device from an active piconet to a target  
piconet. Handover of communications is possible in a  
Bluetooth scatternet which lacks a fixed  
15 infrastructure as well as a Bluetooth system having  
access points forming a fixed infrastructure, or a  
combination thereof.

BACKGROUND OF THE INVENTION

The use of multi-user radio communication systems  
20 has achieved wide popularity in recent years as  
advancements in communication technologies have  
permitted the affordable utilization of such  
communication systems by large numbers of users to  
communicate therethrough.

25 Like other types of communication systems, a  
radio communication system is formed, at a minimum, of  
a sending station and a receiving station  
interconnected by way of a communication channel. In  
a radio communication system, the communication  
30 channel is formed of a radio communication channel. A  
radio communication channel is defined upon a portion  
of the electromagnetic spectrum. A communication

channel defined in a wireline communication system, in contrast, is defined upon a wireline connection extending between the sending and receiving stations. Because a radio communication channel defined upon a portion of the electromagnetic spectrum is used to communicate communication signals between the sending and receiving stations, the need for wireline connection between the sending and receiving stations of a conventional wireline communication system is obviated. The use of a radio communication system to communicate therethrough, as a result, inherently increases the mobility of communication relative to communications in a conventional wireline communication system.

Digital communication techniques have been implemented in radio, as well as other, communication systems. Digital communication techniques generally permit the communication system in which the techniques are implemented to achieve greater communication capacity contrasted to conventional, analog communication techniques.

In a communication system which utilizes digital communication techniques, information which is to be communicated is digitized to form digital bits. The digital bits are typically formatted according to a formatting scheme. Groups of the digital bits, for instance, are positioned to form a packet of data.

Because packets of data can be communicated at discrete intervals, rather than continuously, a frequency band need not be dedicated solely for the communication of data between one communication pair. Instead, the frequency band can be shared amongst a plurality of different communication pairs. The ability to share the frequency band amongst the more

than one communication pair permits a multiple increase in the communication capacity of the system.

Packet-data communications are effectuated, for instance, in conventional LAN (Local Area Networks).

5 Wireless networks, operable in manners analogous to wired LANs, referred to as WLANs (Wireless Local Area Networks) have also been developed and are utilized to communicate data over a radio link. Some of such systems are able to provide for voice, as well as non-voice, communications.

10 A communication standard, referred to as Bluetooth, has been promulgated which provides a standard operating protocol by which to communicate data over a relatively short distance, e.g., about ten meters. The Bluetooth communication standard provides a manner which enables seamless voice and data communication by way of short-range radio links and permits a broad range of devices to be connected easily and quickly by way of the radio links.

20 Proposals have been set forth to provide a wide array of devices with Bluetooth communication capabilities. Mobile computers and mobile phones are exemplary of devices which have been proposed to make use of the Bluetooth communication standard.

25 An advantageous characteristic of the Bluetooth communication standard is the ability to provide combined usability models based upon functions provided by different devices. For instance, using Bluetooth-based communication signals, a communication path can be formed between a PDU (Personal Data Unit) and a cellular phone. And, a second communication path is also formable between a cellular phone and a cellular base station, thereby providing connectivity for both data and voice communication. In this

exemplary implementation, the PDU maintains its function as a computing device and the cellular phone maintains its function as a communication device, while each of the devices provides a specific function efficiently by way of the Bluetooth communication scheme.

Multi-point connections are also provided through the use of a Bluetooth-based communication scheme. While the radio range envisioned pursuant to the Bluetooth communication standard is relatively small, i.e., on the order of ten meters, Bluetooth-based devices can, appropriately positioned, act as bridges to extend the range of the communication of the Bluetooth-based communication signals.

A WIO (Wireless Intranet Office) is also exemplary of a communication system in which Bluetooth-compatible devices can be utilized. In a WIO, typically, voice, and other real-time, communications are provided through the use of a mobile station. Voice communication by way of a WIO provides the advantages of use of a wireless communication system in a cost-effective manner. Voice, as well as other data, can be communicated between mobile stations operable in such a system.

The Bluetooth communication standard defines a piconet, formed of two or more Bluetooth-compatible devices which share a common communication channel. In a WIO or WLAN, the piconet architecture defined in the Bluetooth communication standard is integrated into the WLAN through the introduction of an access point (AP). An access point defines a logical point at which data unit of the wired portion of the LAN enters the piconet defined in the Bluetooth communication standard.

By positioning a plurality of access points at a plurality of spaced-apart locations, a mobile station exiting a communication range encompassed by a first access point enters the communication range encompassed by a second access point.

Analogous to operation of a mobile station in a conventional, cellular communication system in which communication handovers are effectuated to permit continued communication by the mobile station as the mobile station moves throughout a geographical area, a mobile station operable in the LAN similarly would be permitted continued communication if handover of communications between access points would be possible.

While currently, the Bluetooth communication standard does not define a handover method, a manner by which to handover communications of a mobile station from one piconet to another would advantageously facilitate communications in a Bluetooth-compatible communication system.

It is in light of this background information related to wireless communication systems that the significant improvements of the present invention have evolved.

## SUMMARY OF THE INVENTION

The present invention, accordingly, advantageously provides a method, and associated apparatus, by which to handover communications with a mobile communication device, such as a mobile Bluetooth-compatible device, or other communication device, from an active communication device to a target communication device.



Through operation of an embodiment of the present invention, handover of communication is possible between Bluetooth scatternets, or other networks which lack fixed infrastructures. Handover of

5 communications is also possible in a Bluetooth, or other, system having access points forming a fixed infrastructure, as well as also in a system having both scatternets and a fixed infrastructure.

In one aspect of the present invention, apparatus, and an associated method, is provided by which to handover communications with a mobile Bluetooth from one piconet to another in a manner both to permit continued communication as well as to limit packet loss during the handover.

15 When handover is to be effectuated between successive access points of a Bluetooth-compatible WLAN, the mobile Bluetooth device forming the mobile station is initially a slave to the access point with which the mobile Bluetooth device communicates. When  
20 the mobile Bluetooth device travels into an area encompassed by another access point, a handover of communications from the first access point to the subsequent access point is generally desired. Measurements are performed during operation of the  
25 mobile Bluetooth device. For example, measurements are made to determine when a handover should be initiated. In one implementation, power levels, or other of the signals detected at the Bluetooth device communication quality indicia, are measured at  
30 selected intervals.

When the power levels of signals generated by the first access point falls beneath a certain threshold, the Bluetooth mobile device sends an inquiry message to the second access point, forming now a target

access point. The inquiry message inquires of a device address associated with the target access point. When the target access point receives the inquiry, a response is generated, and returned to the mobile Bluetooth device, with the appropriate address and clock information of the target access point. Thereafter, the target access point pushes other Bluetooth devices in the piconet in which the target access point also forms a portion, into reduced-power states, such as SNIFF or HOLD states. If the availability of temporary addresses by which to identify the mobile Bluetooth device is limited, one or more of the other Bluetooth devices associated with the second piconet can be put into a PARK mode by the target access point. When pushed into a PARK mode, the temporary address identifying such Bluetooth device is made available to identify other Bluetooth devices, such as the mobile Bluetooth device of which handover of communications is desired.

In another aspect of the present invention, the master-slave roles of the target access point and the mobile Bluetooth device are exchanged. That is to say, with respect to each other, the mobile Bluetooth device becomes a master and the target access point becomes a slave thereto. The mobile Bluetooth device, prior to the handover, remains as a slave to the access point associated with the first piconet. Time synchronization of the target access point to the mobile Bluetooth device is then effectuated. Because of the time synchronization, the handover of communications from the first piconet to the second piconet can be effectuated without loss of packets of data during the handover due to non-synchronization of timing between the piconets.

In another aspect of the present invention, when selection is made to initiate a handover, the active access point is caused to push all active Bluetooth devices, other than the mobile Bluetooth device and the active access point, into reduced power-level states. Then, the mobile Bluetooth device and the active access point exchange master-slave roles. That is to say, the mobile Bluetooth device becomes a master to the active access point, and the active access point becomes a slave thereto. Thereafter, handover is effectuated of the mobile Bluetooth device from the first piconet to the second piconet and the connection of the mobile Bluetooth device to the first piconet is terminated.

In another aspect of the present invention, handover of communications is effectuated between piconets of a scatternet. Handover of communications is effectuated with a handover of communication from a first piconet to a second piconet. The mobile Bluetooth device and a master device of the second piconet exchange master-slave relationships with respect to each other. Once the mobile Bluetooth device becomes a master with respect to the device which becomes its slave, the mobile Bluetooth device causes such other device to become time synchronized thereto. Thereafter, handover of communications to the second piconet is effectuated.

Because a manner is provided by which to facilitate handover of communications between piconets of a Bluetooth communication system, the convenience of use of the Bluetooth communication system is facilitated.

In these and other aspects, therefore, a method, and associated apparatus, is provided for handing over

communications of a mobile communication device initially operable in a connected state in a first piconet to a second piconet, thereafter to be operable in a connected state in the second piconet. The first piconet includes at least one first- piconet communication device and the second piconet includes at least one second-piconet communication device. The initiation of handover of communications from the first piconet to the second piconet is selected responsive to a communication indicia representative of communications with the mobile communication device. The at least one second-piconet communication device is caused to be come time-synchronized with the communication device. Thereafter, communications with the mobile communication device by way of the second piconet is effectuated. Thereby, the mobile communication device is operated in the connected state in the second piconet.

A more complete appreciation of the present invention and the scope thereof can be obtained from the accompanying drawings which are briefly summarized below, the following detailed description of the presently-preferred embodiments of the invention, and the appended claims.

## BRIEF DESCRIPTION OF THE DRAWING

Figure 1 illustrates a functional diagram of a Bluetooth communication system forming a WLAN (Wireless Local Area Network) in which an embodiment of the present invention is operable.

Figure 2 illustrates a portion of the communication system shown in Figure 1, here representing initial positioning of a mobile Bluetooth device during a communication session.

Figure 3 also illustrates a portion of the communication system shown in Figure 1, here representing positioning of the mobile Bluetooth device when the device is repositioned at a location  
5 at which a handover of communications is desired.

Figure 4 also illustrates a portion of the communication system shown in Figure 1, here also representing positioning of the mobile Bluetooth device at a position at which handover is desired and  
10 in which additional Bluetooth devices are located at the piconet to which the communications are to be handed over during operation of an embodiment of the present invention.

Figures 5A-B illustrates a message sequence  
15 diagram representing messaging generated during operation of an embodiment of the present invention.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring first to Figure 1, a communication system, shown generally at 10, provides for  
20 communication of data with a mobile Bluetooth device 12 operable in a Bluetooth-compatible WLAN (Wireless Local Area Network), or the like. The fixed infrastructure of the WLAN is coupled, by way of a gateway 14 to a packet data network 16, such as the  
25 Internet. A remote station 18 is also coupled to the packet data network. A communication path formed upon a radio link formed between the mobile Bluetooth

device 12 and the network infrastructure of the WLAN, and through the WLAN, the gateway 14, and the packet data network 16 permits communications to be effectuated, for instance, between the mobile  
5 Bluetooth device 12 and the remote station 18.

The network infrastructure of the WLAN is here shown to include a plurality of access points 22-1 through 22-N, each of which is connected by way of a line 24. Each of the access points 22 defines a  
10 coverage area 24, herein referred to as a cell. Coverage areas of adjacent ones of the access points 22 partially overlap.

The WLAN forms a multi-user system permitting a plurality of users, here Bluetooth devices, to  
15 communicate by way of the WLAN. In the exemplary illustration of the figure, the first cell 24 also includes an additional two Bluetooth devices 26, the second the cell 24 also includes two additional two Bluetooth devices 26, and the Nth cell 24 also  
20 includes two Bluetooth devices 26. The Bluetooth devices of each of the cells 24 defines a piconet, operable pursuant to the Bluetooth communication standard.

A piconet need not include a network  
25 infrastructure device, such as an access point 22. A piconet, here referenced by 28, is formed, of any two or more Bluetooth devices including a master Bluetooth device and up to seven slave Bluetooth devices. Piconets are dynamically configurable, and  
30 reconfigurable, again all pursuant to the Bluetooth communication standard. As set forth in the standard, a Bluetooth device can, concurrently, form a portion of more than one piconet. And, the device may form a master Bluetooth device of one piconet and a slave

Bluetooth device of another piconet. Advantage is taken of this capability of a Bluetooth device during operation of an embodiment of the present invention.

A mobile Bluetooth device is permitted movement  
5 throughout an area, here at the least the area encompassed by the WLAN forming a portion of the communication system. Here, the Bluetooth device 12 travels along the path 32, and, during such travel, the Bluetooth device travels through a plurality of  
10 cells-piconets 24-28. As the Bluetooth device 12 travels, handover of communications from one piconet to another is effectuated pursuant to operation of an embodiment of the present invention.

Figure 2 illustrates two of the access points,  
15 access points 22-1 and 22-2 and the respective cells 24 defined by the coverage areas of the access points. Overlapping portions 36 of the two cells 24 are shown in the figure. The mobile Bluetooth device 12 travels along a path indicated by the arrow 32. As shown, the  
20 path along which the device 12 travels causes the mobile Bluetooth device to travel through the area 36 and into the cell 24 defined by the second access point 22-2. When initially-positioned, as shown, the mobile Bluetooth device is initially in a connected  
25 state with the first access point 22-1. Conventionally, the access point 22-1 forms a master and the mobile Bluetooth device forms a slave thereto. When the mobile Bluetooth device is in a connected  
30 Bluetooth device is maintained in time synchronization with the access points.

Figure 3 illustrates subsequent positioning of the mobile Bluetooth device 12 at the area 36 formed of the overlapping coverage areas of the first and

second access points 22-1 and 22-2. The mobile Bluetooth device is operable to determine that a handover of communications is desired, such as by way of measuring power levels, or other communication indicia, of signals transmitted by the access points 22-1 and 22-2. When the power level, or other communication indicia, is greater than a selected threshold, selection of handover is initiated. In addition, the mobile Bluetooth device can enter the inquiry state whenever it likes. For instance, if the signal magnitude of signals generated by the access point 22-1 is weak, i.e., beneath a threshold, the mobile Bluetooth device searches for other possibilities including a new AP, piconet, etc. Establishment of a new connection with the access point 22-2 is attempted by the mobile Bluetooth device pursuant to an INQUIRY process. An INQUIRY message is sent by the mobile Bluetooth device to the access point 22-2 to inquire of a device address identifying the access point. When the access point detects the INQUIRY message, an INQUIRY response message is generated and returned to the mobile Bluetooth device. The INQUIRY response message includes the address and clock information associated with the second access point.

Time synchronization is generally not maintained between piconets, including the piconets which include respective ones of the access points 22. As a result, although the mobile Bluetooth device 12 is time-synchronized to the access point 22-1 of the first piconet, the mobile Bluetooth device is not time-synchronized to the piconet of which the access point 22-2 forms a portion. To be recognized as a Bluetooth unit associated with the second access point 22-2, the



Bluetooth device should be synchronized together with the access point 22-2. When time-synchronized to the piconet of which the access point 22-2 forms a portion, it is necessary to have a time  
5 synchronization because of the frequency hopping system. The frequency hopping sequence is generated from the address and clock timing. To be recognized as a Bluetooth unit, an internal clock of the mobile Bluetooth device corresponds with the clock of the  
10 access point 22-2.

During operation of an embodiment of the present invention, when handover of communications is selected to be initiated, the access points 22-2, forming the master Bluetooth device relative to other Bluetooth  
15 devices 26 in the piconet, causes such other Bluetooth devices 26 to enter a reduced power-level state. Such Bluetooth devices are caused, for instance, to enter the SNIFF or HOLD modes, both defined in the Bluetooth communication standard. As each Bluetooth device is  
20 identified by a MAC address, also described as an active member address (AM\_ADDR), if the availability of MAC addresses is limited, some of the Bluetooth devices 26 are selectably alternately caused to enter a PARK mode, as also defined in the Bluetooth  
25 communication standard. When a Bluetooth device is caused to enter the PARK mode, the device releases the MAC address (i.e., AM\_ADDR) by which the device is identified. When the MAC address (i.e., AM\_ADDR) is released, the address can be reused to identify  
30 another Bluetooth device. In a system in which tiers of service, analogous to QoS (Quality of Service) are defined, Bluetooth devices to which lower-tier services are provided are first pushed into the PARK mode while Bluetooth devices to which higher-tiers of

service are provided are more likely to be prevented from entering the PARK mode.

Currently, the mobile Bluetooth unit 12 is a master of the access point 22-2 and the access point 22-2 is a slave of the mobile Bluetooth unit 12. Once the other Bluetooth devices 26 have been caused to enter a reduced power-level mode, the master-slave roles of the mobile Bluetooth device 12 and the access point 22-2 are exchanged. That is to say, with respect to one another, the mobile Bluetooth device 12 becomes a slave to the access point 22-2. And, at the same time, the Bluetooth device 12 remains a slave to the first access point 22-1 and remains time-synchronized with the access point 22-1. But, the mobile Bluetooth device 12 becomes a slave of the access point 22-2, and the time synchronization of the second piconet so defined is effectuated with respect to a second clock. Once this connection between the mobile Bluetooth device 12 (a slave) and the access point 22-2 is completed, the mobile Bluetooth device 12 is disconnected out of a communication link for the first access point 22-1 of the first piconet.

While the just-described, exemplary implementation describes operation in which the mobile Bluetooth device requests the exchange of master-slave roles with the access point 22-2, in another implementation, the access point 22-2 controls all the Bluetooth devices within its cell 24, and the access point 22-2 is aware of an appropriate timing scheme which shall accept the mobile Bluetooth device 12.

Figure 4 again illustrates positioning of the mobile Bluetooth device 12 at the area 36, here also subsequent to selection of initiation of handover of communications from the first access point 22-1 to the

second access point 22-2. Figure 4 represents alternate operation of an embodiment of the present invention. Here, the mobile Bluetooth device maintains its connection with the first access point  
5 22-1 after a connection with the second access point 22-2. By maintaining connections with both of the access points, the possibility of loss of packets of data is reduced. Here, the other Bluetooth devices 26 located in the coverage area encompassed by the access  
10 point 22-1 are pushed into reduced power-level modes. That is to say, the other Bluetooth devices are pushed into a SNIFF, a HOLD, or PARK mode, again, according to a tier-of-service pursuant to which such Bluetooth devices are operable. Then, the mobile Bluetooth  
15 device 12 and the first access point 22-1 exchange master-slave roles such that the Bluetooth device 12 becomes the master of the access point 22-1 and the access point becomes a slave thereto. The access point 22-1 remains a master to the other Bluetooth  
20 devices 26. Subsequent to completion of handover of communications, the Bluetooth device 12 terminates the connection with the access point 22-1.

The message sequence diagram, shown generally at 52, of Figure 5, illustrates messaging generated  
25 during operation of an embodiment of the present invention by which communications with the mobile Bluetooth device 12 are handed over from a first access point 22-1 to a second access point 22-2. It is again noted that, while operation of the exemplary  
30 embodiment of the present invention is described with respect to a communication system having a fixed infrastructure, operation is analogously implementable and describable with respect to an infrastructure-free Bluetooth scatternet, or the like.

As noted previously with respect to the preceding figures, the mobile Bluetooth device is initially in a connection with the first access point 22-1. The initial connection between a Bluetooth device 12 and the first access point is indicated by the segment 54 in the figure. The second access point 22-2 is also initially in a communication connection with other Bluetooth devices 26 and with which a piconet is formed. Here, the other Bluetooth devices are divided into a first set of Bluetooth devices operable pursuant to a high tier, i.e., a high QoS level, of service and Bluetooth devices operable pursuant to a low tier of service. The connections between the second access point and the Bluetooth devices of the two groups are indicated by the segments 56 and 58 in the figure.

When, and as illustrated previously with respect to Figures 3 and 4, the mobile Bluetooth device 12 is positioned at the area 36 (shown in Figures 2-4) at which selection is made to initiate handover of communications from the first access point to the second access point, an INQUIRY message is generated by the mobile Bluetooth device and transmitted to the second Bluetooth device. The inquiry message is indicated in the figure by the segment 62. The access point provides an INQUIRY response, indicated by the segment 64, which is returned to the mobile Bluetooth device. Responsive thereto, and as indicated by the segment 66, a PAGE message is then transmitted by the mobile Bluetooth device to the second access point 22-2. And, as indicated by the line segment 68, a PAGE response message is returned by the second access point to the mobile Bluetooth device.

Then, and as indicated by the segment 72, a connection is established between the Bluetooth device 12 and the second access point. Details of the establishment of a connection between two Bluetooth devices is described in detail in the Bluetooth communication standard, such as the Bluetooth specification 1.0b. In the connection, the mobile Bluetooth device forms a master device and the second access point forms a slave thereto. Blocks 74 and 76 indicate that the mobile Bluetooth device 12 forms a master for its connection with the second access point and a slave to the first access point 22-1 while the second access point remains a master for the other Bluetooth devices 26 while becoming a slave to the mobile Bluetooth device 12.

Thereafter, LMP messages LMP\_SNIFF or LMP\_HOLD are sent to the second group of Bluetooth devices 26. Sending of such messages are indicated by the line segment 78 in the figure. LMP\_ACCEPTED messages are returned by such Bluetooth devices. Transmission of a LMP\_PARK message, indicated by the segment 84, is also shown in the figure. Such message instructs one or more of the other Bluetooth devices into a PARK mode if MAC addresses (i.e., AM\_ADDR) are unavailable to be reassigned to, for instance, the mobile communication device. When a Bluetooth device enters a PARK mode, the MAC address used to identify the device is released, thereby to become available for use by another Bluetooth device. A LMP\_ACCEPTED message responsive thereto is indicated by the segment 86.

The sequence diagram also illustrates transmission of analogous LMP\_SNIFF and LMP\_HOLD messages, indicated by the segment 88 transmitted to

the first group of other Bluetooth devices 26. The first group of Bluetooth devices are operated pursuant to other tiers of service, and LMP\_ACCEPTED messages generated responsive thereto are indicated by the line segment 92.

The sequence diagram further illustrates a switch request, LMP\_SWITCH\_REQ message 94 sent by the mobile Bluetooth device 12 to the second access point 22-2 and this message can also be initiated by the access point 22-2 to the mobile Bluetooth device 12 and, responsive thereto, an accept message LMP\_ACCEPTED, indicated by the segment 96. Finally, subsequent to handover, a disconnect, or remove message is sent by the mobile Bluetooth device to the first access point 22-1, here indicated by the line segment 98.

Thereby, through operation of an embodiment of the present invention, handover of communications from one Bluetooth device to another Bluetooth device is effectuated to permit continued communications with a mobile Bluetooth device. The Bluetooth devices from which, and to which, communications are handed-over form fixed infrastructure devices or mobile devices, or any combination thereof.

The preferred descriptions are of preferred examples for implementing the invention, and the scope of the invention should not necessarily be limited by this description. The scope of the present invention is defined by the following claims.

We claim:

1. A method for handing over communications of a mobile communication device initially operable in a connected state in a first piconet to a second piconet, thereafter to be operable in a connected state in the second piconet, the first piconet including at least one first-piconet communication device and the second piconet including at least one second-piconet communication device, said method comprising:
  - selecting initiation of handover of communication from the first piconet to the second piconet responsive to a communication indicia representation of communications with the mobile communication device;
  - causing the at least one second-piconet communication device to become time-synchronized with the mobile communication device; and
  - effectuating communications with the mobile communication device by way of the second piconet, thereby to operate the mobile communication device in the connected state in the second piconet.
2. The method of claim 1 wherein the at least one second-piconet communication device comprises a second-piconet pre-handover master communication device and at least one pre-handover slave device, and wherein, prior to said operation of causing, said method comprises the additional operation of:
  - placing the at least one pre-handover slave device in a reduced power level state.

3. The method of claim 2 wherein said operation of causing the second-piconet communication device to become time-synchronized comprises:

making the pre-handover master  
5 communication device a slave to the mobile  
communication device; and

time-synchronizing the slave formed of  
the pre-handover master device and the at least one  
pre-handover slave device to the mobile communication  
10 device.

4. The method of claim 1 wherein said method of causing the second-piconet communication device to become time-synchronized comprises:

making the second-piconet communication  
15 device a slave to the mobile communication device; and

time-synchronizing the slave formed of  
the second-piconet communication device to the mobile  
communication device.

5. The method of claim 1 further comprising the  
20 additional operation of removing the mobile  
communication device out of the first piconet  
subsequent to effectuation of the communications  
during said operation of effectuating communications.



6. The method of claim 1 wherein the communication indicia responsive to which initiation of handover of communications is selected during said operation of selecting comprises signal power levels  
5 of signals detected by the mobile communication device when operated in the first piconet.

7. The method of claim 1 wherein the at least one first-piconet communication device comprises a first-piconet pre-handover master communication device  
10 and at least one first-piconet pre-handover slave device and wherein, prior to said operation of causing, said method comprises the additional operation of:

placing the at least one first-piconet,  
15 pre-handover slave device in a reduced power-level state.

8. The method of claim 1 further comprising the additional operation, prior to said operation of causing the at least one second-piconet communication  
20 device to become time-synchronized of:

making the first-piconet pre-handover master communication device a slave to the mobile communication device.

9. The method of claim 8 wherein the at least  
25 one second-piconet communication device comprises a second-piconet pre-handover master communication device and at least one second-piconet slave communication device and wherein, prior to said operation of causing, said method comprises the  
30 additional operation of:

placing the at least one second-piconet, pre-handover slave device in a reduced power-level state.

10. The method of claim 9 wherein said operation  
5 of causing the at least one second-piconet communication device to become time-synchronized comprises:

making the second-piconet pre-handover master communication device a slave to the mobile  
10 communication device; and

time-synchronizing the slave formed of the second-piconet pre-handover master device and the at least one second-piconet pre-handover slave device to the mobile communication device.

15 11. The method of claim 9 wherein the second-piconet pre-handover communication device comprises a target access point forming a portion of a network infrastructure, the access point defining a target cell, and wherein said operation of selecting  
20 initiation of handover occurs when the mobile communication device enters the target cell.

12. The method of claim 1 wherein the at least one first-piconet communication device, the at least one second-piconet communication device, and the  
25 mobile communication device each comprises a Bluetooth-compatible (BT) device, and wherein said operation of selecting initiation of handover comprises selecting initiation of handover of communications from a first BT piconet to a second BT  
30 piconet.

13. The method of claim 12 wherein the at least one BT device of which the second piconet is formed comprises a second-piconet pre-handover slave BT device and wherein, prior to said operation of  
5 causing, said method comprises the additional operation of:

placing the at least one pre-handover BT slave device in a reduced power-level state.

14. The method of claim 13 wherein the reduced  
10 power-level state into which the pre-handover BT slave device is placed comprises a HOLD mode.

15. The method of claim 13 wherein the reduced power-level state into which the pre-handover BT slave device is placed comprises a SNIFF mode.

15 16. The method of claim 13 wherein the reduced power-level state into which the pre-handover BT slave device is placed comprises a PARK mode.

17. The method of claim 12 wherein each BT device is identified by a temporary identifier  
20 selected from a set of temporary identifiers and wherein the reduced power-level state into which the pre-handover BT slave device is placed is a state in which the pre-handover BT slave device is stripped of the temporary identifier.

25 18. Apparatus for facilitating handing over communications of a mobile communication device initially operable in a connected state in a first piconet to a second piconet, thereafter to be operable in a connected state in the second piconet, the first  
30 piconet including at least one first-piconet

communication device and the second piconet including at least one second-piconet communication device, said apparatus comprising:

a handover initiation selector coupled  
5 to receive indications of a communication indicia representative of communications with the mobile communication device, said handover initiation selector for selecting initiation of handover of communications from the first piconet to the second  
10 piconet responsive to the indications of the communication indicia; and

a time-synchronizer coupled to receive indications of selection by said handover initiation selector of selection of the initiation of handover,  
15 said time synchronizer for causing the at least one second-piconet communication device to become time-synchronized with the mobile communication device.

19. The apparatus of claim 18 wherein the at least one second-piconet communication device  
20 comprises a second-piconet pre-handover master communication device and at least one second-piconet pre-handover slave device and wherein said time-synchronizer is further for placing the at least one second-piconet pre-handover slave device in a reduced  
25 power-level state.

20. The apparatus of claim 19 wherein said time synchronizer makes the pre-handover master communication device a slave to the mobile communication device and time-synchronizes the slave  
30 formed of the pre-handover master device to the mobile communication device.

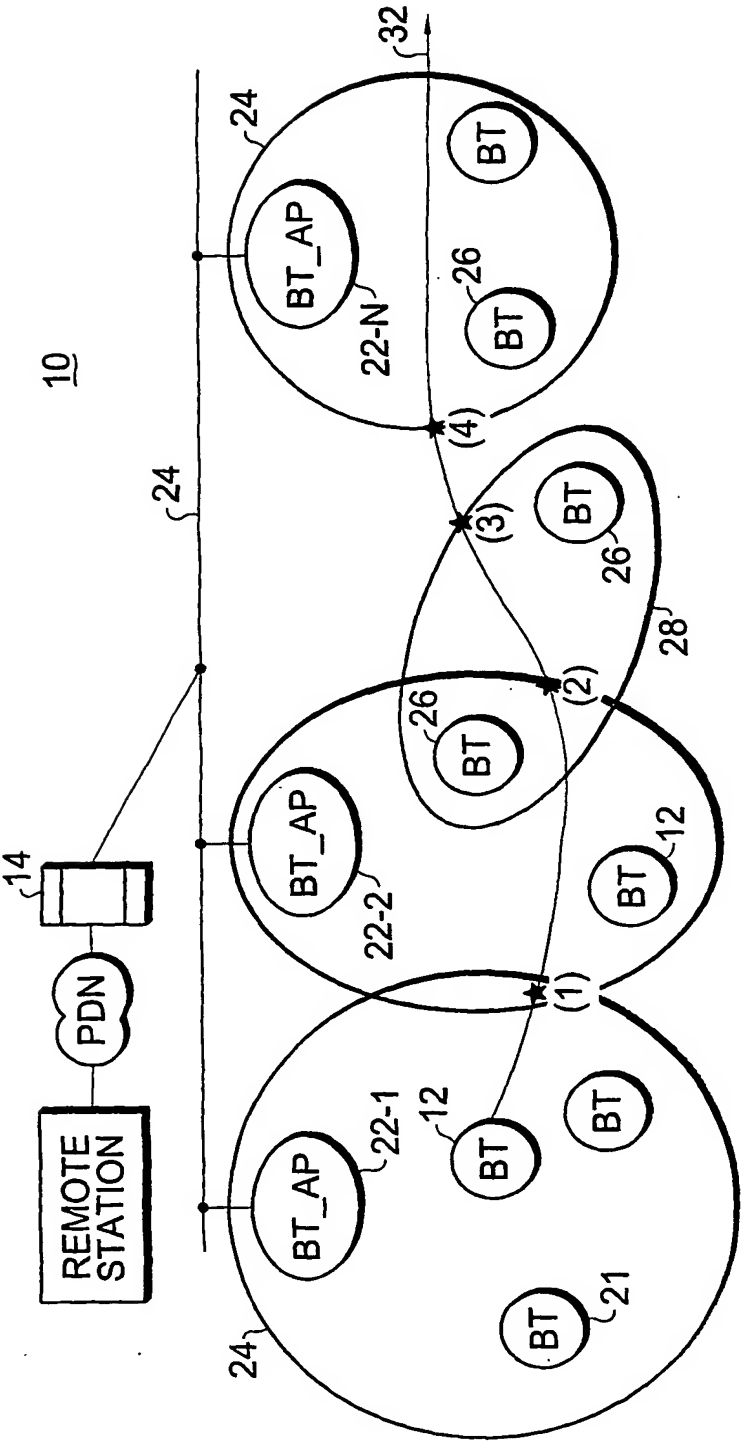


FIG. 1

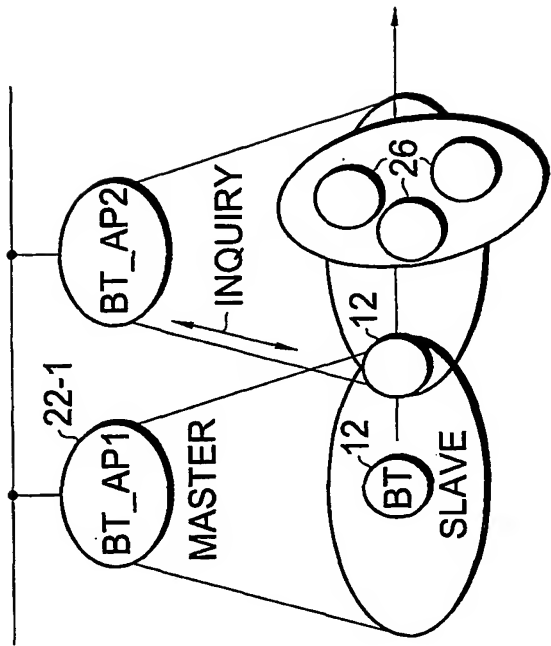


FIG. 3

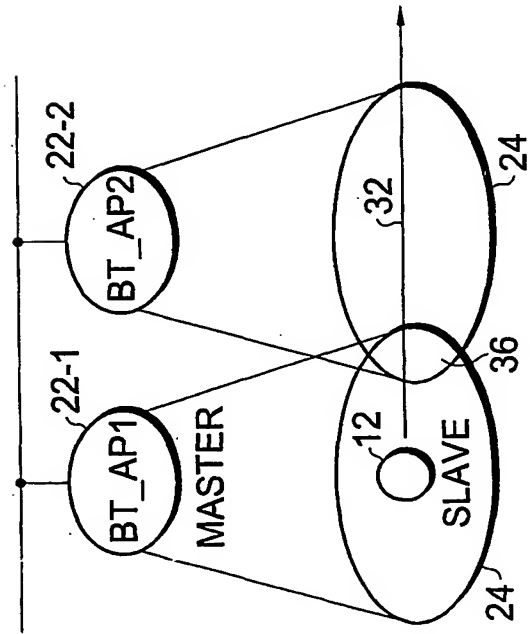


FIG. 2

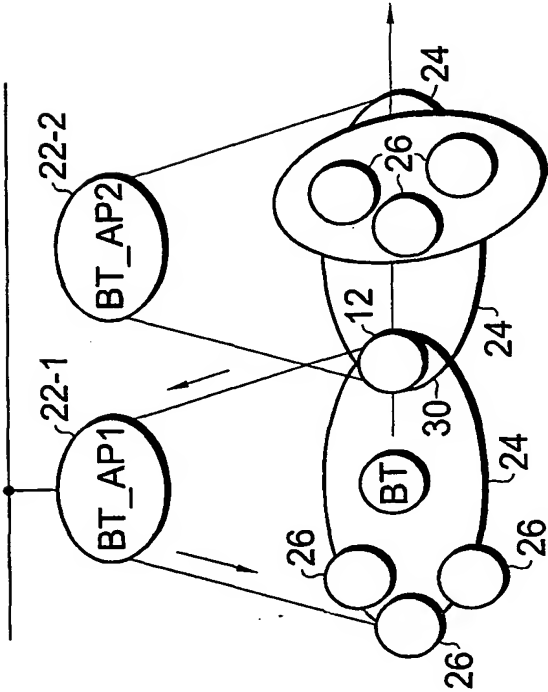


FIG. 4

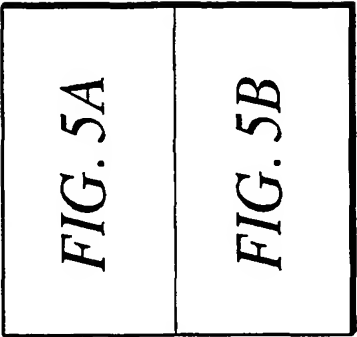


FIG. 5





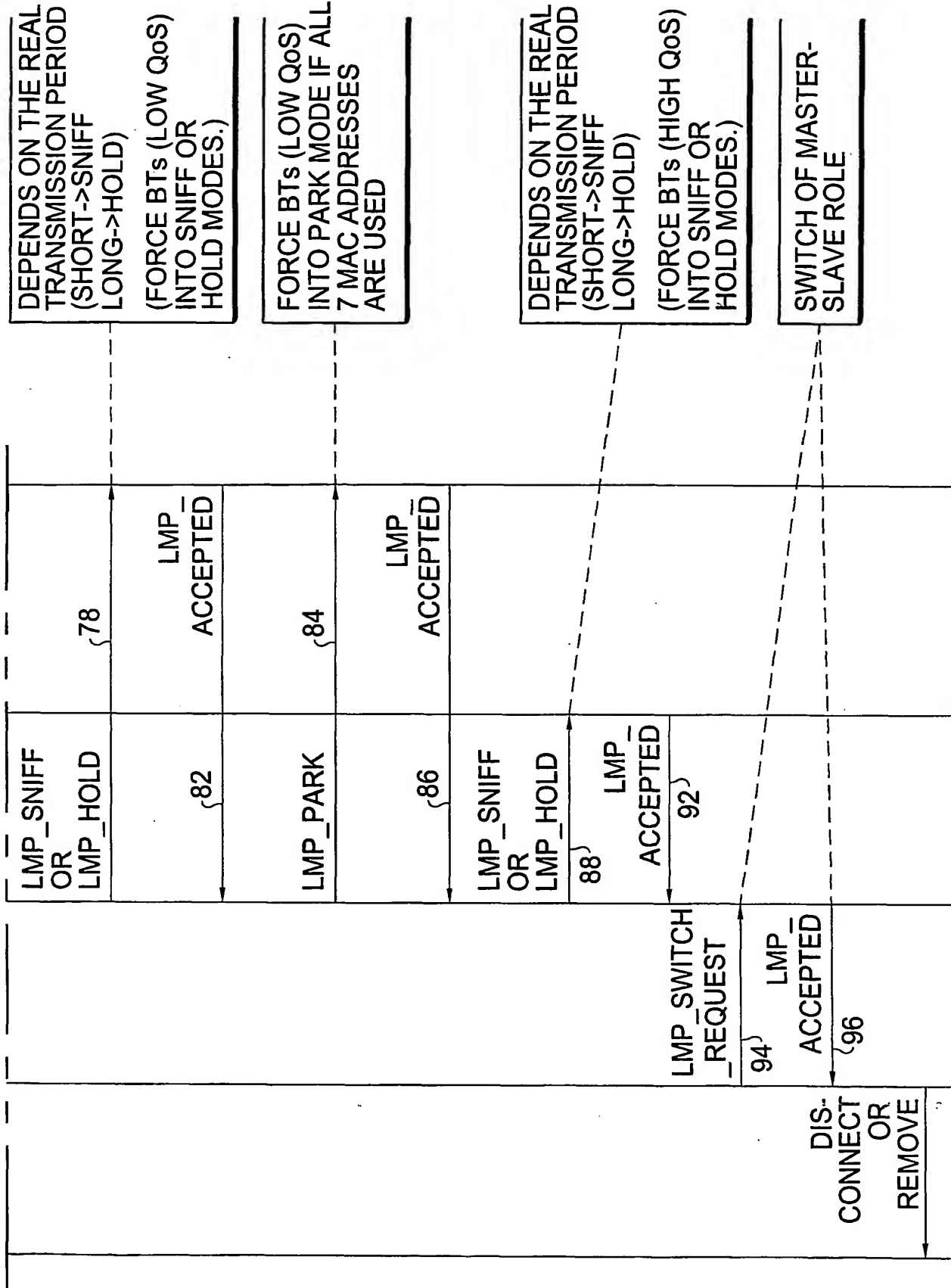


FIG. 5B

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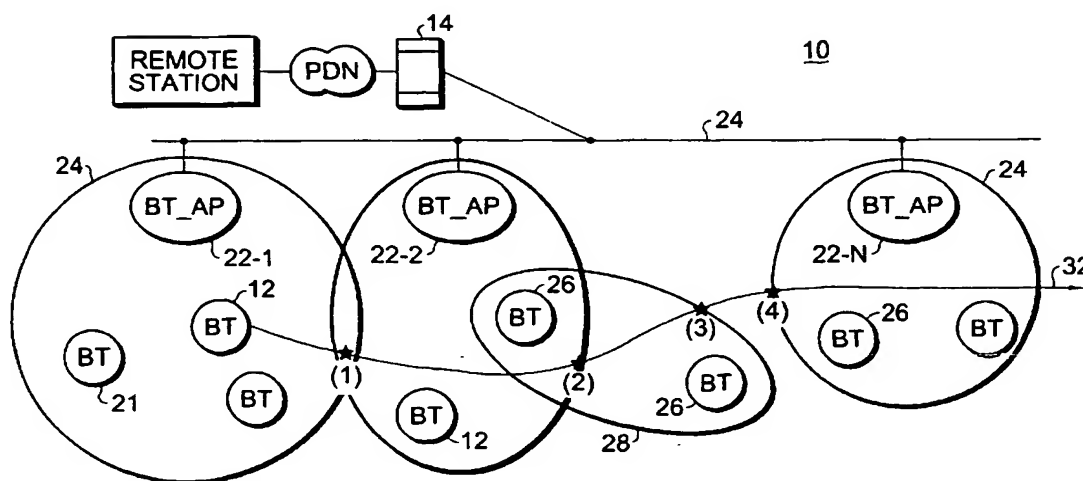
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(54) Title: METHOD AND APPARATUS FOR PERFORMING HANDOVER IN A RADIO COMMUNICATION SYSTEM



(57) Abstract: A method, and associated apparatus, facilitates handover of communications with a mobile Bluetooth device (12) operable to communicate packet data with other Bluetooth devices (12, 26). Handover of communications is effectuated between fixed-infrastructure access points (22) or other mobile Bluetooth devices (12, 26) formed in a scatternet. The device (12, 26) to which communications are to be handed-over becomes a slave to the Bluetooth device (12) with which communications are ongoing, thereby to permit time synchronization thereto.



*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

## INTERNATIONAL SEARCH REPORT

International Application No

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A. CLASSIFICATION OF SUBJECT MATTER  
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According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H04Q H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 026 297 A (HAARTSEN JACOBUS CORNELIS) 15 February 2000 (2000-02-15) column 2, line 37 -column 3, line 25	1,4,8, 10,12,18
A	column 5, line 52 -column 6, line 64	2,3,5-7, 9,11, 13-17, 19,20
E	WO 01 78246 A (ARAZI NITZAN ;BARAK HAIM (IL); COMMIL LTD (IL); FRIEDMAN MARK M (I) 18 October 2001 (2001-10-18) page 5, line 17 -page 9, line 4 -/--	1,6,12, 18



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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication where appropriate, of the relevant passages	Relevant to claim No.
X	<p>ALBRECHT M ET AL: "IP services over Bluetooth: leading the way to a new mobility"            LOCAL COMPUTER NETWORKS, 1999. LCN '99.            CONFERENCE ON LOWELL, MA, USA 18-20 OCT. 1999, LOS ALAMITOS, CA, USA, IEEE COMPUT. SOC, US,            18 October 1999 (1999-10-18), pages 2-11,            XP010358529            ISBN: 0-7695-0309-8            the whole document</p>	1,18
A	<p>GARG S ET AL: "MAC SCHEDULING POLICIES FOR POWER OPTIMIZATION IN BLUETOOTH: A MASTER DRIVEN TDD WIRELESS SYSTEM"            VTC 2000-SPRING. 2000 IEEE 51ST. VEHICULAR TECHNOLOGY CONFERENCE PROCEEDINGS. TOKYO, JAPAN, MAY 15-18, 2000, IEEE VEHICULAR TECHNOLOGY CONFERENCE, NEW YORK, NY: IEEE, US,            vol. 1 OF 3. CONF. 51,            15 May 2000 (2000-05-15), pages 196-200,            XP000970607            ISBN: 0-7803-5719-1            the whole document</p>	1-20

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Information on patent family members

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